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CIRCULAR MICROSTRIP PATCH ANTENNA WITH CSRR FOR COMMUNICATION SYSTEMS

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ABSTRACT

In this paper, a new design of antenna is supplied with the use of U- slot loading and use of CSRR technology with improvement in return loss with the frequency shifting to decreased value. It is determined that the properties of the antenna can be easily changed by varying the width of the U-slot, width and radius of the CSRR and spacing among the ringed of CSRR. The method of U- slot loading is used for running antenna in twin band and CSRR approach to make antenna compact and CSRR for compactness is used. The simulated consequences of the proposed antenna are confirmed with available experimental results. Proposed antenna may be used in lots of twin band Wi-Fi communications

KEYWORDS: *Communication systems, Antenna & CSRR.*

1. INTRODUCTION

Wherein the excessive overall performance with reduced size and cost is required with, the microstrip antenna has the exceptional advantage. Those antennas are low profile, without easy to use with planar and non-planar surfaces, simple and low cost because of technology circuit generation. Microstrip antennas have some negative aspects like low performance, low energy handling capacity and many others. [1]

Several patch shapes are used within the microstrip antenna e.g. rectangular patch and circular patch etc. It is far observed that a round patch is more compact than a conventional square/rectangular patch antenna [2]. Researchers targeted on the compactness and completed unique techniques like slot loading, superstrate strategies etc. U-slot on patch presents the compactness, bandwidth enhancement and dual-band operation [3].

These days researchers are focusing on the metamaterial to increase compactness of the antennas. Metamaterial is the substance which does not exist in real terms that realized in artificial manner which gives the electromagnetic confinement. Metamaterial is classified as negative index substances and single index materials [4]. In negative index substances both permittivity and permeability are negative. In single index metamaterial, only one of the permittivity and permeability is negative and each aren't negative at the same time. This is categorised because the ENM (epsilon negative media) wherein permittivity is negative and permeability is positive. On the otherhand, in MNN (mu-negative media), permeability is negative and permittivity is positive [5]. Using the metamaterial is to improve important antenna functions like impedance matching, gain, bandwidth, performance, front-to-back ratio and so on. Metamaterial approach is the unique way to lessen the size of the antenna in respect to the prevailing size reduction strategies of antenna [6].

The reality of original medium has been proposed in [7] which consists of a bulky combination of steel wires and split ring resonators (SRRs). SRRs are the planar structures and can be replaced by planar strips [8]. The electromagnetic properties of SRRs had been shown in [9]. The circuit for the SRR and CSRR are given in fig. 1, in which C is the entire capacitance between the rings of SRR. SRR can be taken because the resonant dipole which can be excited via an axial magnetic field [10]. The resonant frequency of circular patch for the dominant mode is described by the equation (1)

$$f = \frac{1.8412 \times 3 \times 10^{11}}{2 \times 3.14 \times \sqrt{\epsilon_r} \times a} \quad \text{.......................(1)}$$

Where a is the radius of the circular patch.

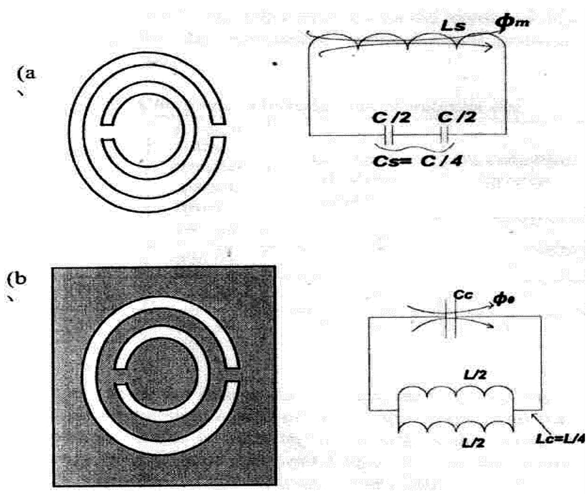

Fig. 1 Technology for (a) SRR (b) CSRR

In proposed antenna the size of the antenna is reduced by use of CSRR as shown in comparisons of results.[11-12] The concept of frequency shifting towards the lower value is presented with the use of CSRR due to the characteristics of the metamaterial.

2. ANTENNA DESIGN

Fig. 2 gives the geometrical structure of circular U-slot microstrip patch. Fig. 3 shows the geometrical view of the CSRR on the ground of the proposed antenna with its notations

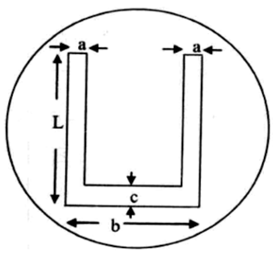

Fig. 2 Sketch and geometrical structure of patch view of U –slot loaded circular microstrip patch

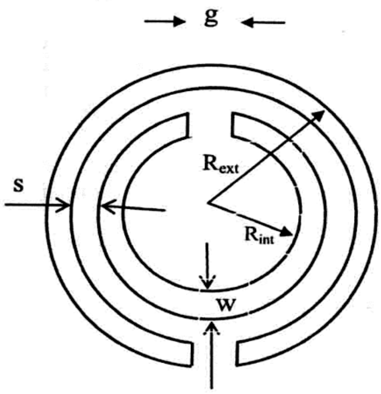

Fig.3 Geometrical view of the CSRR on the ground of the proposed antenna

Table 1 shows the dimensions of the proposed antenna and the cuts in CSRR on the ground aligned in x-direction.

Table.1 Design Parameters of proposed antenna design

Substrate material-Fr4	ε_r = 4.4
Thickness of dielectric substrate	h = 1.6mm
Radius of circular patch	r = 6.88mm
Length & width of rectangular slots	L = 8mm, b = 8mm, c = 1mm, a = 1mm
Radius of the CSRR on the ground	R_{ext} = 5.8mm, R_{int} = 3.1 mm s = w = 1mm g = 1.5 mm

The physical dimensions are evaluated and put in the Ansoft HFSS as a 3D EM field solver to reach the final real structure.

3. RESULTS AND DISCUSSIONS

In this section, simulated results and experimental results of the proposed antenna are discussed.

3.1 Simulated Results

First of all the round patch antenna with none adjustments is simulated and the resonant frequency is 5.7 GHz with the return loss of -11.97 dB. The simulated result is given in fig. 3. Now the first proposed U-slot loaded round microstrip patch antenna with CSRR having the cuts in x direction is designed and simulated [13]. The proposed antenna suggests the resonant frequencies at 3.47 GHz and 3.98 GHz with the return loss of - 37.4 dB and -13.7 dB respectively. The simulated results are shown in Fig. 4

Table. 2 Comparison in reduction of antenna size

Frequency (GHz)	**Area of the circular patch (mm^2)**	**Area of proposed antenna (mm^2)**	**% reduction in area**
6	153.84	-	-
5	220.72	-	-
3.98	348.63	153.84	55.1
3.4	477.39	153.84	67.7

It is clear from the results that the antenna becomes dual band which proves the significance of the U-slot loading and the reduction of size or in the other terms the shifting of the resonant frequency from towards the lower frequency is shown in the table 2. The effect of the rotation in the CSRR structure on ground is shown by the variation in CSRR cuts. In variation of CSRR positions are used using rectangular slots.

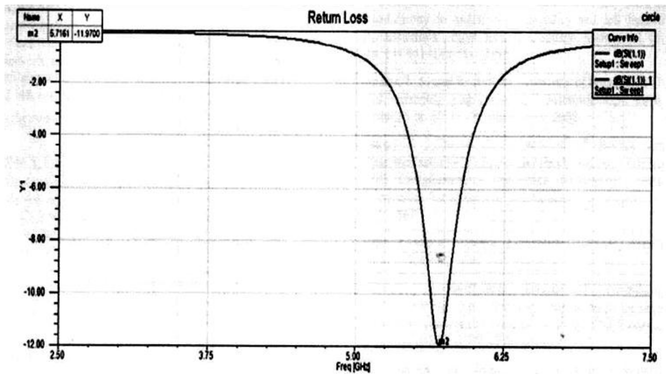

Fig. 4 Simulated results of bandwidth of proposed Antenna

3.2 Experimental results

The proposed antenna is fabricated on the FR4 substrate material with the substrate thickness of h = 1.6mm.. Results obtained by fabricated antenna are approximately equal to the simulated results by the Ansoft HFSS.

4. CONCLUSION

Finally, this paper presents an electrically small U-slot loaded microstrip patch antenna as a shape of Complementary split Ring Resonator (CSRR). During the course of investigation, it is found that the simulated antenna resonates at 5.71 GHz with return loss of -11.38 dB. The proposed antenna (with U-slot and CSRR) increases the matching upto-37.47 dB at the 3.47 GHz and -13.7dB at the frequency 3.98 GHz. The Circular patch antenna and U-slot loaded circular microstrip patch antenna with CSRR have been simulated using commercial softwares (ansoft HFSS) and found that it establishes a good result with the experimental results.

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